Tests of the GRETINA 3-crystal prototype detector: II. Characterization

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The use of multi-segmented HPGe detectors in gamma-ray tracking arrays relies on the position information derived from the pulse shapes of the main and induced signals. To accomplish this requires, in addition to the traditional energy resolution performance, a rather detailed characterization of the segment boundaries and also of the signal shapes.

To test the GRETINA prototype detector, a scanning table was built to allow a precise positioning of the collimators with respect to the crystals. The setup is shown in the following figure and consists of x, y and z stepping motors controlled via a LabView GUI. For the x-y scanning we used a ^{241}Am (60keV) source of 114μCi with an aperture of 2mm. In these conditions we detect approximately 20 counts/s and typical measurements run for 1min. An example is shown in Fig.2. The intensity of the 60 keV peak in each of the segments varies as the y position is changed and the profile allows the determination of the segment boundaries. With a data set that corresponds to the scanning of 6 lines, intercepting the 6 segment boundaries, we found that the deviations with respect to their nominal center are less than 0.2mm and the orientation angles less than 1 deg. A similar procedure is used to determine the z boundaries.

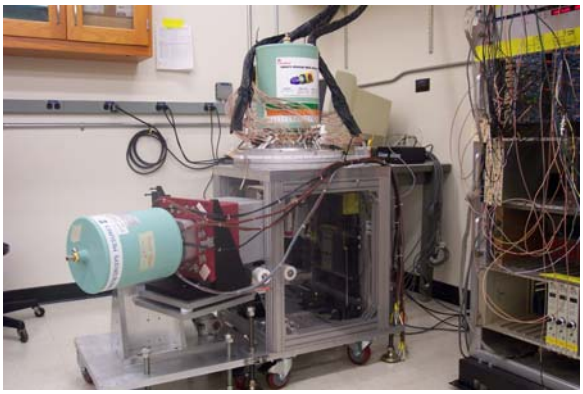

Fig. 1 Picture of the scanning table used in the characterization of the GRETINA prototype.

Shown also in Fig. 1 is the side support assembly for a clover Ge detector plus a BGO module. This setup is required for the signal basis characterization. In these measurements, a 1mCi ^{137}Cs source shines a pencil beam of 1 or 2 mm to a given x, y position. A 90 deg Compton scattered gamma is selected by a z-collimator and detected in one of the clover leaves. Prompt coincidences between the GRETINA module and the clover detector with the correct energy deposition in each crystal define a single interaction point at lab coordinates x, y, z., which translate to a position in the crystal.

The measured signals from the different segments and different positions can be compared with the calculated signals. A typical coincidence run lasts a day, and we obtain approximately 200 signals for that position, enough to minimize the noise contribution. An example is shown in Fig.3 . Characterization measurements are still in progress, but preliminary results are very encouraging and in terms of position performance, already meet the specification requirements of GRETINA.

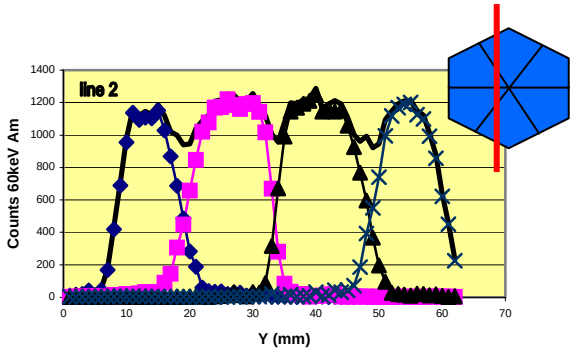

Fig. 2 Intensity profile of the 60keV γ-ray detected in 4 segments, as a function of the positions of the collimator along line 2, indicated in the insert.

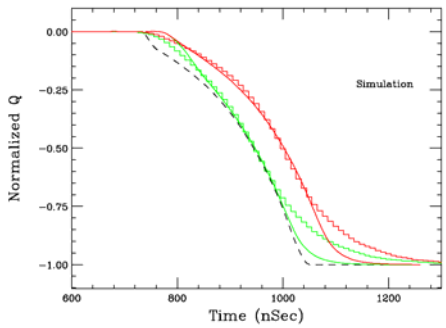

Fig. 3 An example of a pulse shape measurement. The two measured signals (histograms) correspond to a 5mm change in radial position and are compared to the calculations (solid lines).

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